

**Modelling Service Life and Life-Cycle Cost of  
Steel-Reinforced Concrete**

**Report from the NIST/ACI/ASTM Workshop held in  
Gaithersburg, MD on November 9-10, 1998**

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United States Department of Commerce  
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**United States Department of Commerce**

William M. Daley, *Secretary*

**Technology Administration**

Gary R. Bachula, *Acting Under Secretary for Technology*

**National Institute of Standards and Technology**

Ray Kammer, *Director*

## 1. INTRODUCTION

The workshop was held in the Hilton Hotel, Gaithersburg, Maryland, on November 9 and 10, 1998. NIST was asked to take the lead in organizing the workshop at a meeting of ACI's Strategic Development Council in May, 1998, in which the need for standards for modeling service life and life-cycle cost was pointed out. NIST accepted the task and formed a steering committee the members of which are listed in Appendix 1. The steering committee drafted the objectives for the workshop and drew up the initial invitation list. The list included persons who i) had contributed models on the corrosion of steel in concrete, ii) were users or potential users of models, and iii) were viewed as representatives of standards-writing committees that might be expected to be asked to establish the standards that would be needed. The list of the 40 persons who participated in the workshop is also given in Appendix 1.

The objectives for the workshop were:

1. To review current models for determining the service life and life-cycle cost of steel-reinforced concrete subjected to chloride-induced corrosion of the steel;
2. To reach agreement on an approach to development of a comprehensive model that would provide a suitable basis for standardization;
3. To identify new data and test methods, if any, needed to support development of the model; and
4. To recommend actions to be taken to develop the model and propose it for standardization.

The agenda for the workshop is given in Appendix 2. After welcoming remarks, the workshop began with a presentation from Marta Castellote of the Eduardo Torroja Institute of Construction Sciences, Spain, who reviewed the objectives and plans for RILEM Technical Committee TMC, Testing and Modelling Chloride Penetration in Concrete; (RILEM is the International Union of Research and Testing Laboratories for Materials and Structures). The RILEM committee is chaired by Carmen Andrade of the Eduardo Torroja Institute. There followed a series of nine invited presentations concerning models for prediction of the service life and life-cycle cost of chloride-exposed, steel-reinforced concrete from leaders in the field from Canada, Denmark, Sweden, and the United States. The presentations helped ensure that all participants had an appreciation of types of model that had been, or were being, developed.

The formal presentations were followed by two half-day working group (WG) sessions, with four working groups in each. In the first session, all four groups, WGs 1 through 4, were asked to address the question, "How could a framework for development of a standard, or standards, for service life and life-cycle cost of chloride-exposed, steel-reinforced concrete best be developed?" In the second working group session, each of the four groups had a different assignment, as indicated by their names: WG5, Chloride Transport Mechanisms and Test Methods; WG6, Chloride Thresholds for Corrosion Initiation; WG7, Corrosion Rate and Time to Rehabilitate or Replace; and WG8, Service Life Prediction and Life-Cycle Cost.

The memberships of the groups are given in Appendix 3, with designations of the chairman, co-chairman, and a NIST staff member assigned as a recorder and to assist as needed.

In this report, summaries of the invited presentations are given first; they are followed by working group reports and a report from the closing session at which recommendations for action were made. Additional sections before the appendixes are a summary of the results of the workshop and a list of references supplementing the summaries of the invited presentations. Appendixes 4, 5 and 6 are abstracts submitted by three invitees who were unable to attend the workshop.

On a sad note, it must be mentioned that James (Jim) Clifton, who played an important part in the workshop, died suddenly on January 19. Because of his many contributions to concrete science and technology, Jim was well known to most of the workshop participants. It therefore seemed fitting to include a tribute to Jim at the front of this report.